

A NEW SPECIES OF *PENTAGONIA* (RUBIACEAE: HIPPOIDEAE)  
FROM SOUTHERN PERU

Charlotte M. Taylor

Missouri Botanical Garden  
P.O. Box 299  
St. Louis, Missouri 63166-0299, U.S.A.  
charlotte.taylor@mobot.org

John P. Janovec

Botanical Research Institute of Texas  
1700 University Dr.  
Fort Worth, Texas 761-7-3400, U.S.A.  
jjanovec@brit.org

Roy E. Gereau

Missouri Botanical Garden  
P.O. Box 299  
St. Louis, Missouri 63166-0299, U.S.A.  
roy.gereau@mobot.org

ABSTRACT

Recent floristic exploration in the Madre de Dios River basin and its tributary the Los Amigos River in southern Peru has continued the discovery of Rubiaceae species new to science, including the new species described here. *Pentagonia australis* C.M. Taylor & Janovec (Hippotidae) is distinguished by the combination of its subsessile leaves that are truncate to rounded at the base, its well developed and regularly lobed calyx limbs, and its tubular yellow corollas with short lobes. Also corolla form and size are detailed for the first time for two similar species found in Peru, *P. microcarpa* L. Andersson & Rova and *P. pachiteana* Cornejo.

RESUMEN

Recientes exploraciones florísticas en la región del río Madre de Dios y su tributario el río Los Amigos en el sur del Perú han contribuido al descubrimiento de especies de Rubiaceae nuevas para la ciencia, incluida la especie descrita a continuación. *Pentagonia australis* C.M. Taylor & Janovec (Hippotidae) se distingue por la combinación de las hojas subsésiles con la base truncada a redondeada, el limbo del cáliz bien desarrollado y regularmente lobado, y la corola tubular de color amarillo con lobos cortos. Además la forma y tamaño de la corola se describe por primera vez para dos especies similares que se hallan en Perú, *P. microcarpa* L. Andersson & Rova y *P. pachiteana* Cornejo.

KEY WORDS: Rubiaceae, *Pentagonia*, Hippotidae, Peru, IUCN Red List

INTRODUCTION

The neotropical genus *Pentagonia* Benth. (Rubiaceae: Hippotidae) comprises about thirty to forty species of shrubs and small trees, most with quite large leaves, found at low to montane elevations from Guatemala to western Brazil and central to southern Peru (Taylor 2002; Andersson & Rova 2004). *Pentagonia* is distinguished by its robust and sometimes rather succulent habit; its well developed interpetiolar stipules that are triangular and twisted in bud; its leaves with the secondary veins evident but the higher order venation inconspicuous and the surfaces finely striate due to a network of fibers (Rova & Andersson 1995); its axillary, capitate to cymose inflorescences; its relatively large, fleshy and fibrous, five-merous, bisexual flowers; its corollas with a well developed tube and valvate lobes; and its rather leathery, two-locular, berry-like fruits with numerous angled seeds on axile placentas. *Pentagonia* belongs to the small neotropical tribe Hippotidae (Rova & Andersson 1995) and is notable in the Rubiaceae for its several species with deeply pinnatifid to rarely partially pinnate leaves (e.g., *P. tinajita* Seem.). It is also unusual in its floral biology, described by McDade (1986). The flowers are protandrous and are wholly staminate at first, with the stigmas held below the anthers with their receptive surfaces pressed together. The arrangement of the androecium is unusual in *Pentagonia* because the anthers are oriented at 90° to the longitudinal axis of the corolla, and are positioned asymmetrically all on the lower side of the corolla near the middle of its tube and at slightly different levels due to differences in filament lengths as well as the bending of some of the filaments. After anthesis the style elongates to position the stigmas just below the anthers, and the stigmas separate to expose the receptive surfaces. *Pentagonia* has not

been studied as a whole and most of its individual species are also not well known. These plants often have an unbranched, monocaule (i.e., "pole") habit, which together with their unusually large leaves (up to 200 × 120 cm on petioles up to 30 cm long, e.g., *P. grandiflora* Standl.) makes the collecting of museum specimens difficult; extensive field observations are still needed to understand this genus. Taylor (2002) reviewed characteristics and taxonomy of *Pentagonia* in some detail and six additional species have been individually described (Cornejo 2006, 2009, 2010; Taylor & Gereau 2010), but the genus has not yet been comprehensively reviewed or studied.

The identification of the specimens included in the new species described below was complicated by lack of information in the published descriptions of the flowers of two other *Pentagonia* species also found in Amazonian Peru, *P. microcarpa* L. Andersson & Rova and *P. pachiteana* Cornejo. Flowering specimens of both of these species and additional fruiting specimens of *P. pachiteana* are now available, and updated morphological descriptions are presented here for those species. Also newly documented here is the occurrence of *P. pachiteana* in western Brazil.

The new species described below was discovered among specimens made by the Andes to Amazon Biodiversity Program of the Botanical Research Institute of Texas during exploration of the Madre de Dios River basin and its tributary, the Los Amigos River. This is a region of lowland Amazonian tropical to subtropical forest and wetlands in southern Peru that is not well known to science. As part of the southwestern Amazon Basin, this region contains what is probably the largest and least disturbed area remaining of upper Amazonian and lower Andean ecosystems (Foster et al. 1994), including moist, semi-deciduous tropical to subtropical forest and wetlands dominated by *Mauritia flexuosa* L.f. (Arecaceae) in the lowlands and premontane forest of the Andean foothills (Householder et al. 2010). The region is marked by a distinct four- to five-month dry season (June through September or October) and receives 2,000–2,900 mm of rain annually (Gentry & León 1997). It has been widely recognized as an important center of biological diversity, with world record numbers of birds, tabanid flies, tiger beetles, damselflies, dragonflies, and butterflies (Stewart 1988). Threats to preservation of the forest occur in the form of hunting, gold mining, timber extraction, road construction, and slash and burn agriculture, but fortunately a large system of protected areas exists in the region, including Manú and Bahuaj-Sonene National Parks and the Los Amigos Conservation Concession.

#### METHODS

Descriptions follow the format used by Taylor and Gereau (2010) and Taylor (2002), and as in those works morphological terms follow Lawrence (1951). Measurements given below in the technical descriptions indicate length unless otherwise indicated. The species are treated in alphabetical order. Additional collection data for the specimens cited here and high-resolution digital images of several of them are available on the Internet and can be accessed by either the species name or the collector and collection number: for the newly described species at <http://atrium.andesamazon.org>, and for the previously described *Pentagonia* species at [www.tropicos.org](http://www.tropicos.org).

*Conservation Status Assessment Methodology.*—The study presented here is taxonomic and floristic. The objectives are enumeration of the species that occur in the area of tropical Central and South America, and taxonomy of the species that belong to this genus of Rubiaceae. The methods employed here correspond only to these objectives, thus this study is based on survey of specimens collected over a number of years using varied survey methods aimed at various objectives. The specimens here used to delineate the geographic range and commonness of this new species were located through a non-exhaustive survey of several herbaria, and no field studies have been done targeting the occurrence of this species where it is known or expected to grow. Thus the floristic information presented here is a simplified presence report based on incomplete survey of the available data, which are uneven and incomplete for this region (Schulman et al. 2007). Knowledge of the true geographic range and the population size and dynamics of a species are essential for understanding the threats to its existence, and thus to understanding its actual conservation status. Documentation of the existence of a species based on one or several museum collections does not provide adequate data to evaluate these factors.

A conservation assessment is provided for the new species treated here using IUCN categories and crite-

ria (IUCN 2001) based on the totality of our current knowledge. The basis for these assessments in the form of a map and the calculated assessment parameters are available under the corresponding species name at <http://www.tropicos.org> (assessment parameters for the map can be seen using "Show Detail"). The species distribution was mapped in ArcView GIS 3.2 (ESRI 1999), with the grid cell size used for calculating Area of Occupancy (AOO) set at the maximum allowable value of 3.16 km (IUCN Standards and Petitions Working Group 2008); because there were only two collecting points, the IUCN Rating tool (Moat 2007) could not be used. This assessment is not being submitted to IUCN for publication on the Red List (<http://www.iucnredlist.org>), and the basis for this assessment should be carefully evaluated by the reader.

#### TAXONOMY

***Pentagonia australis*** C.M. Taylor & Janovec, sp. nov. (**Fig. 1**). TYPE: PERU. MADRE DE DIOS. Prov. Manú: Los Amigos Biological Station, Madre de Dios River, ca. 7.0 km upriver from mouth of Río Los Amigos, Trocha Playa 25 m, 12°30'S, 70°02'W, 250 masl, 24 Jun 2003, A.P. Maceda 723 (HOLOTYPE: USM; ISOTYPE: BRIT-06486).

Haec species a *Pentagonia microcarpa* L. Andersson & Rova foliis ad basem angustioribus atque corolla tubulari flava lobis multo brevioribus distinguitur.

Shrubs and small trees to 2.5 m tall, unbranched; main stems rather stout, quadrangular or somewhat flattened to subterete, glabrous. **Leaves** opposite; blade obovate to broadly obovate, 36–61 × 14–18 cm, drying papery to stiffly papery, adaxially glabrous, abaxially glabrous or sometimes puberulous to densely strigillose on principal veins, tapering for basal 2/3, at base 1.5–2.2 cm wide and abruptly rounded to truncate; secondary veins 16 to 19 pairs; **petioles** 0.1–0.5 cm, glabrous; **stipules** triangular, 33–40 mm, adaxially sericeous, acute, deciduous. **Inflorescences** capitate to subcapitate, sessile, with 4 to 8 flowers; bracts narrowly ligulate to elliptic-oblong, 7–15 mm, obtuse to rounded, glabrous except margins sericeous. **Flowers** sessile or subsessile; ovary portion slenderly ellipsoid, ca. 4 mm, sericeous; **calyx** limb yellow to red, externally sericeous, internally glabrous, regularly lobed, tubular portion cylindrical, 5–6 mm, lobes 5, ligulate to narrowly ligulate, 6–8 mm, obtuse to rounded, with margins sericeous; **corolla** yellow or yellowish green, tubular, externally densely sericeous, internally glabrous, tube ca. 19 mm, at middle ca. 2 mm diam., 2–2.5 mm diam. at mouth, lobes 5, narrowly triangular, 3–3.5 mm, acute; **anthers** narrowly oblong, 2–3 mm, positioned just above middle of tube and all on one side, overlapping but at different heights; **style** ca. 9 mm, **stigmas** narrowly oblong, ca. 2 mm. **Fruit** subglobose, yellow, 0.9–1.2 cm diam., sparsely strigillose to glabrescent, densely beset with small lentils; seeds not seen.

**Habitat, Distribution, and Phenology.**—This species is known from moist, seasonally inundated, semideciduous floodplain forests at an elevation of ca. 270 m in the region of the confluence of the Los Amigos and Madre de Dios Rivers in Madre de Dios, southeastern Peru. Apparently it grows on sandy soil mosaics and perhaps near springs and small streams overlying rich, alluvial, floodplain forest soils. In some years it may withstand one to two months or more of 50–150 cm inundation during the peak rainy season (December through February). It has been collected in flower and fruit in May and June, on some plants simultaneously, which corresponds to the early dry season.

**Conservation Assessment.**—With a very small Area of Occupancy (AOO), this species meets the geographic range criterion for Endangered. Although its two known localities are from within the Los Amigos Conservation Concession, the species has not been documented from the less vulnerable national protected areas in the region (Manú National Park, Tambopata Reserved Zone, and Bajujaje-Sonene National Park). Because plants of *Pentagonia* are physically difficult to make into museum specimens and not always collected in botanical surveys, this species is very possibly more common than the limited number of specimens suggests. However it seems highly improbable that further collections will demonstrate an AOO exceeding 500 km<sup>2</sup>, the upper threshold for the Endangered category. With a limited number of collection localities and a continuing decline in the quality of habitat in the floodplain forests of the Madre de Dios River basin due to illegal and mechanized gold mining (Swenson et al. 2011), this species is here evaluated as Endangered: EN B2ab(iii).

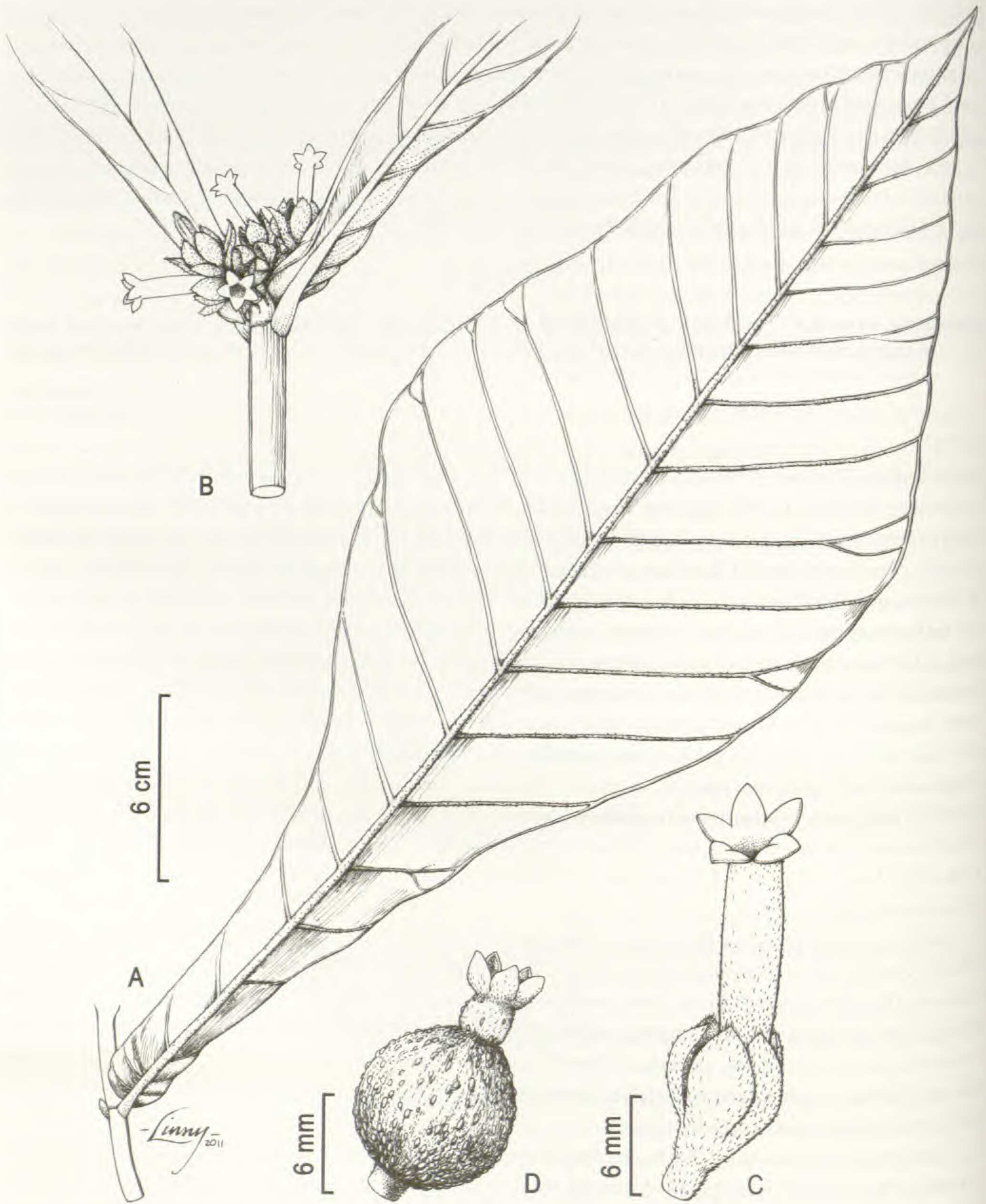


FIG. 1. *Pentagonia australis* C.M. Taylor & Janovec. A, Portion of stem with leaf. B, Inflorescence. C, flower at anthesis. D, Fruit. A, B based on *Maceda 1369* (BRIT); C, D based on *Maceda 723* (BRIT). Artist: Linny Heagy.

This new species can be recognized within *Pentagonia* by the combination of its subsessile or only very shortly petiolate leaves, with the blade glabrous on the lower surface and narrowed from above the middle to its base, and then abruptly truncate to rounded at the base; its sessile, capitate or subcapitate inflorescences with yellow or yellow-green flowers; its calyx limb that is regularly lobed; its corollas with the tube cylindrical and

the lobes relatively short; and its rather small fruits. This new species is found to the south of the previously documented range of *Pentagonia*, for which *P. pachiteana* previously represented the southern limit. The range of this genus is thus now extended by several hundred km, and the specific epithet of this new species refers to its relatively southern distribution. *Pentagonia australis* has floral biology similar to that described by McDade (1986).

*Pentagonia australis* is similar to *P. microcarpa*, discussed in more detail below. However *P. microcarpa* can be separated by its leaves that are broader at the base, 3–6 cm wide, its red to pinkish red flowers, and its larger, funnellform corollas with the tube about twice as wide at the mouth as at the middle. Also similar to this new species and discussed below is *P. pachiteana*, which can be separated from *P. australis* by its leaves that are acute to cuneate at the base with short to well developed petioles, 0.5–2 cm long, its shorter triangular calyx lobes, 2.5–4 mm long, and its funnellform corollas with the tube about twice as wide at the mouth as at the middle. Two other *Pentagonia* species with subsessile or only shortly petiolate leaves that are rounded to truncate or cordulate at the base are also found in Peru, *P. williamsii* Standl. and *P. subauriculata* Standl., but they can both be separated from *P. australis* by their spathaceous calyx limbs (i.e., completely fused in bud and splitting irregularly as the corolla emerges). *Pentagonia subsessilis* L. Andersson & Rova also has similar subsessile leaves and the calyx limb regularly lobed; however *P. subsessilis* is known only from western Ecuador and differs in its red calyx limbs with the tubular portion longer, ca. 9 mm long, and its larger white corollas, with the tube ca. 26 mm long and the lobes 8–10 mm long.

PARATYPES. **PERU. Madre de Dios. Prov. Manú:** Puerto Maldonado, Los Amigos Biological Station, Madre de Dios River, ca. 7.0 km upriver from mouth of Río Los Amigos, Trocha Playa 25 m, 12°30'S, 70°02'W, 250 masl, A.P. Maceda 1369 (BRIT, USM); vic. trail to Cocha Lobo, 12°30'S, 70° 02'W, 250 masl, J.P. Janovec, P. Macedo, C. Nayahuacca, & V. Yumbato 1984 (BRIT, USM).

***Pentagonia microcarpa*** L. Andersson & Rova, Fl. Ecuador 74:37, fig. 6. 2004.

**Flowers** with ovary portion slenderly ellipsoid, strigillose to strigose; **calyx** limb red or pinkish red, externally sericeous, internally glabrous, regularly lobed, tubular portion 3–6 mm, lobes 5, ligulate to elliptic-oblong, 10–15 mm, acute to obtuse; **corolla** red or pinkish red, funnellform, externally glabrous, tube 22–27 mm, at middle 3.5–4 mm diam., at mouth 6–9 mm diam., lobes 5, ovate, 7–8 mm, obtuse to acute; **anthers** narrowly oblong, 2–3 mm, positioned just below middle of corolla tube and all on one side, overlapping but at different heights; **style** ca. 9 mm, **stigmas** spatulate, ca. 1.8 mm.

This species is known from Amazonian Ecuador and northern Peru (Andersson & Rova 2004). The form and sizes of the leaves, stipules, inflorescences, and fruits and the elevational range documented by more recent specimens still fall within the description and range given in the protologue. The flower measurements here are based on the two collections cited below. *Pentagonia microcarpa* has floral biology similar to that described by McDade (1986).

Selected Specimens Studied: **PERU. Loreto. Maynas Prov.:** Yanamono, Río Amazonas, L. Hendrix 258 (MO), R. Vásquez & N. Jaramillo 11098 (MO).

***Pentagonia pachiteana*** Cornejo, Harvard Pap. Bot. 11:22, fig. 2. 2006.

**Flowers** with ovary portion slenderly ellipsoid, ca. 4 mm, strigillose to strigose; **calyx** limb green, externally sericeous to glabrescent, internally glabrescent, regularly lobed, tubular portion ca. 4 mm, lobes 5, ligulate to triangular, 2.5–4 mm, obtuse to acute; **corolla** white to greenish white, funnellform, externally sericeous to glabrous, tube 20–25 mm, at middle ca. 4.5 mm diam., at mouth ca. 8 mm diam., lobes 5, triangular, 6–7 mm, acute; **anthers** and **stigmas** not seen. **Fruits** subglobose, yellow with red spots, ca. 15 × 14 mm, strigillose to glabrescent, densely finely lenticellate; mature seeds not seen.

Initially this species was reported only from eastern Peru, where it is still apparently only known from the type collection, but it has recently been additionally documented from the adjacent state of Acre, Brazil. All the collections seen were made at 200–300 m elevation. The flower measurements given here are based on two collections, an isotype at MO and Oliveira et al. 674 (MO); however the flower material available is quite limited,

and the flowers were not dissected. The fruit description given here is based on *Daly et al.* 764 (MO) and *Daly et al.* 10019 (MO).

Selected Specimens Studied: **BRAZIL. Acre. Mun. Feijó:** Rio Muru, Seringal Lancha, proprietário Sr. Antonio Francisco Ferreira, A.R.S. Oliveira, C. Figueiredo, L. Lima, M. Silveira, D. Daly, & C. Ehringhaus 674 (MO). **Mun. Manoel Urbano:** Rio Purus, margem esquerda, Seringal Itatinga, M. Silveira, L.A. Lima, P.A. Verraz, J. Ribamar, & E. Consuelo 1505 (MO). **Mun. Marechal Taumaturgo:** Rio Juruá, Reserva Extrativista do Alto Juruá, S of confluence with Rio Acuriá & N of São João do Breu, Colocação Tapaúna, D.C. Daly, M. Silveira, R. Saraiva, F. Walthier, & J. Gebhards 7648 (MO). **Mun. Santa Rosa:** Alto Rio Purus, left bank, Seringal Santa Helena, D.C. Daly, H. Kunchmeister, D. Gomes da Silva, L. Lima, & E. Consuelo 10019 (MO).

#### ACKNOWLEDGMENTS

We thank D. Daly for access to specimens, T. Franklin and A. Neill for assistance with specimens at BRIT, A. P. Maceda and F. Cornejo for collaboration in the field, L. Heagy for the excellent illustration, an anonymous reviewer for helpful suggestions, and R. Magill and S. Sohmer for significant facilitation of this work. Field work in Peru was kindly supported by the Botanical Research Institute of Texas, the Gordon and Betty Moore Foundation, the U.S. National Science Foundation Biotic Surveys and Inventory program (grant number DEB-0717453), the Discovery Fund of Fort Worth, Texas, the Beneficia Foundation, and the Amazon Conservation Association. This work would not have been possible without research, collection, and export permits issued by the former Instituto de Recursos Naturales (INRENA) and the Directorio General de Flora and Fauna Silvestre (DGFFS) of Peru.

#### REFERENCES

- ANDERSSON, L. AND J.H.E. ROVA. 2004. 162. Rubiaceae (Part 4), Tribe 9. Hipotidaeae. *Fl. Ecuador* 74:1–46.
- CORNEJO, X. 2006. Two new species of *Pentagonia* (Rubiaceae-Hipotidaeae) from Ecuador and Peru. *Harvard Papers Bot.* 11:19–24.
- CORNEJO, X. 2009. Two new species of *Pentagonia* (Rubiaceae, Hipotidaeae) from Colombia and Ecuador. *Novon* 19:25–31.
- CORNEJO, X. 2010. *Pentagonia lanciloba*, a new species of Rubiaceae (Hipotidaeae) from northwestern Ecuador. *Brittonia* 67:7–11.
- ESRI (ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE). 1999. ArcView GIS 3.2. ESRI, Redlands, CA.
- FOSTER, R., T.A. PARKER III, A.H. GENTRY, L.H. EMMONS, A. CHICCHÓN, T. SCHULENBERG, L. RODRÍGUEZ, G. LAMAS, H. ORTEGA, J. ICOCHEA, W. WUST, M. ROMO, J. ALBAN CASTILLO, O. PHILLIPS, C. REYNEL, A. KRATTER, P.K. DONAHUE, AND L.J. BARKLEY. 1994. The Tambopata-Candamo Reserved Zone of Southeastern Perú: A Biological Assessment. RAP Working Papers, Vol. 6. Conservation International.
- GENTRY, A.H. AND B. LEÓN. 1997. Tambopata region, Peru. In S. D. Davis, V. H. Heywood, O. Herrera-MacBryde, J. Villalobos, and A. C. Hamilton, eds. *Centres of plant diversity: a guide and strategy for their conservation*, Volume 3 – the Americas. WWF and IUCN, Oxford, England. Pp. 355–259.
- HOUSEHOLDER, E., J.P. JANOVEC, A. BALAREZO MOZAMBITE, J. HUINGA MACEDA, J. WELLS, R. VALEGA, H. MARUENDA, AND E. CHRISTENSON. 2010. Diversity, natural history, and conservation of *Vanilla* (Orchidaceae) in Amazonian wetlands of Madre de Dios, Peru. *J. Bot. Res. Inst. Texas* 4:229–245.
- IUCN [INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES; UNIÓN INTERNACIONAL PARA LA CONSERVACIÓN DE LA NATURALEZA Y RECURSOS NATURALES (UICN)]. 2001. IUCN Red List Categories and Criteria, Version 3.1. IUCN, Gland, Switzerland and Cambridge, United Kingdom. <http://www.iucn.org>.
- IUCN STANDARDS AND PETITIONS WORKING GROUP. 2008. Guidelines for using the IUCN Red List Categories and Criteria. Version 7.0. IUCN, Gland, Switzerland and Cambridge, United Kingdom. <http://www.iucn.org>.
- LAWRENCE, G.H.M. 1951. *Taxonomy of vascular plants*. The MacMillan Co., New York.
- MCDADE, L.M. 1986. Protandry, synchronized flowering, and sequential phenotypic unisexuality in neotropical *Pentagonia macrophylla* (Rubiaceae). *Oecologia (Berl.)* 68:216–223.
- MOAT, J. 2007. Conservation assessment tools extension for ArcView 3.x, version 1.2. GIS Unit, Royal Botanic Gardens Kew. <http://www.kew.org/gis/projects/cats/catsdoc.pdf>
- ROVA, J.H.E. AND L. ANDERSSON. 1995. A reevaluation of the tribes Hipotidaeae and Tammsieae (Rubiaceae). *Nordic J. Bot.* 15:269–284.

- SCHULMAN, L., T. TOIVONEN, AND K. RUOKOLAINAN. 2007. Analysing botanical collecting effort in Amazonia and correcting for it in species range estimation. *J. Biogeogr.* 34:1388–1399.
- STEWART, P.D. 1988. Tambopata Reserved Zone, southeast Peru. *Oryx* 22:95–99.
- SWENSON, J.J., C.E. CARTER, J.-C. DOMEQ, AND C.I. DELGADO. 2011. Gold mining in the Peruvian Amazon: global prices, deforestation, and mercury imports. *PLoS ONE* 6(4):e18875. doi: 10.1371/journal.pone.0018875
- TAYLOR, C.M. 2002. Rubiacearum americanarum magna hama pars IX. New species and a new combination in *Hippotis* and *Pentagonia* (Hippotideae) from central and western South America. *Novon* 12:555–562.
- TAYLOR, C.M. AND R.E. GEREAU. 2010. Rubiacearum americanarum magna hama pars XXIV: new species of Central and South American *Bouvardia*, *Hillia*, *Joosia*, *Ladenbergia*, *Pentagonia*, and *Posoqueria*. *Novon* 20:470–480.